Clinical course of phacoemulsification wound burns

Alan Sugar, MD, Robert M. Schertzer, MD, FRCSC

ABSTRACT

Purpose: To present 3 cases illustrating the outcomes of phacoemulsification corneal wound burns.

Setting: A university referral center.

Methods: This was a retrospective case series.

Results: Three patients developed corneal wound burns during phacoemulsification of cataract. All eyes developed from +7.00 to +15.00 diopters of astigmatism in the axis of the incision. In 2 eyes, the astigmatism decreased over several months. The third had permanent high astigmatism and corneal edema requiring corneal transplantation.

Conclusions: Corneal wound burns occurring during phacoemulsification can have serious effects on the cornea, including corneal edema and severe astigmatism. In the milder cases, the astigmatism decreases spontaneously over several months. *J Cataract Refract Surg 1999; 25:688–692 © 1999 ASCRS and ESCRS*

Phacoemulsification has become the dominant mode of cataract extraction because of its efficiency, control, and use of small incisions. Sight-threatening complications are rare. Some complications, however, may have increased as the unintended effects of technological advances such as very small incisions, viscoelastic materials, and small-bore phacoemulsification needles. To emulsify the lens nucleus, the phacoemulsification handpiece changes electrical energy to mechanical energy that vibrates the metal tip. This vibration creates shock waves that emulsify the lens. The friction of this process, however, generates heat that is dissipated by the flow of irrigation fluid around the outside of the needle and aspiration of fluid through the needle's bore.

Thermal corneal burns sustained during phacoemulsification, so-called phacoburns, have been mentioned in passing during instruction of phacoemulsification and discussion of intraoperative complications since the technique's introduction in 1967.[1] Relatively little has been published, however, about the etiology of this condition and almost nothing about its clinical course or natural history.[2–5] We present 3 cases to illustrate the range of outcomes from this possibly common and likely underreported condition.

Patients and Methods

Case 1

A 77-year-old mildly hyperopic woman had phacoemulsification of a cataract in the left eye in June 1994. The referring surgeon stated that there was a "problem with flow," and a severe corneal burn of the superior limbal wound developed. The procedure was completed but was complicated by capsule rupture and vitreous loss; a posterior chamber intraocular lens (IOL) was inserted. The wound was closed by sutures and a conjunctival flap.

Reprint requests to Alan Sugar, MD, 1000 Wall Street, Ann Arbor, Michigan 48105, USA.

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At the first postoperative visit, the eye had severe corneal edema with striae directed toward the wound, superior corneal stromal whitening, and a defect in the superior iris. The patient was treated with topical and systemic corticosteroids. Stromal melting over the corneal opacity was noted at 1 month and healed over 2 months with a bandage soft contact lens. Sutures were removed 2 months postoperatively. The patient had constant pain and tearing for 2 to 3 months, and visual acuity was never better than finger counting.

When seen for consultation 10 months after phacoemulsification, visual acuity in the left eye corrected to 20/300 with -7.00 $+15.00 \times 90$. Keratometry was $35.50/51.00 \times 90$. Computerized corneal topography showed severe superior flattening and inferior steepening (Figure 1). Slitlamp examination showed diffuse corneal edema, greatest superiorly, with superior stromal scarring and superficial vascularization. The superior half of the cornea, including the area of the wound, appeared grossly flat. The wound itself did not appear to be gaping or excessively tight. The anterior chamber was deep centrally with a superior sector iris defect and peripheral anterior synechias. The IOL was centered in the capsular bag. Corneal thickness measured 0.68 mm optically. Pressures and fundi were normal. Examination of the right eye was normal except for cataract.

Penetrating keratoplasty (PKP) was advised. In August 1995, the referring physician performed PKP using a 9.0 mm donor and an 8.5 mm recipient trephine. When the patient was last examined in November 1995, the graft was doing well, with 3.50 diopters (D) of astigmatism by retinoscopy and visual acuity correctable to 20/200. The patient died of heart disease 1 month later.

Case 2

A 74-year-old woman had phacoemulsification through a scleral tunnel incision in the left eye in October 1994. At the start of nuclear sculpting, the superior cornea instantly whitened. The procedure was completed with posterior chamber IOL implantation, and the wound was closed with 3 10-0 nylon sutures. At 2 weeks, visual acuity corrected to 20/200 with -3.25 $+6.00 \times 90$ and superior corneal scarring was present. In December, visual acuity corrected to 20/80 with -8.00 $+7.00 \times 120$.

The patient was seen in consultation in June 1995. At that time, visual acuity corrected to $20/20^{-}$ with -2.50 $+1.75 \times 125$. Keratometry was $45.75/48.25 \times 114$, and computerized topography showed severe superonasal steepening in a pattern suggestive of keratoconus, only inverted (Figure 2). Slitlamp examination showed a 3.0×4.0 mm superonasal corneal stromal scar (Figure 3). Gaping or tightness of the wound was not apparent. A strand of vitreous extended from the superior pupil margin to the wound site. The posterior chamber IOL was well centered and placed anterior to the anterior capsule. The right anterior segment was normal except for a well-positioned posterior chamber IOL. Pressure and fundus examinations were normal. Endothelial specular microscopy showed cell densities of 1940 cells/mm^2 in the right eye and 1040 cells/mm^2 in

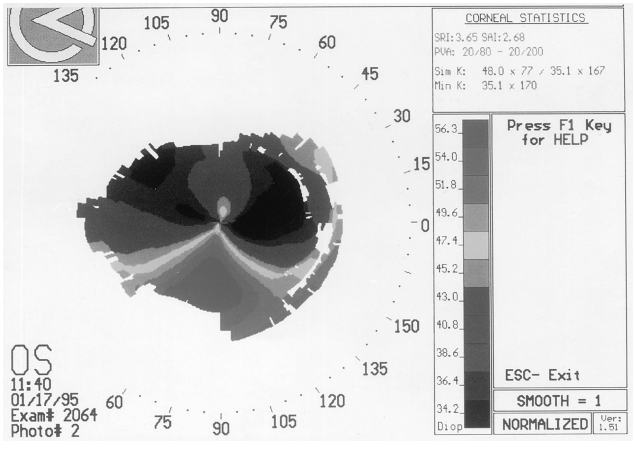

Figure 1. (Sugar) *Case 1*. Computerized corneal topography shows severe corneal steepening with localized flattening over the cataract wound.

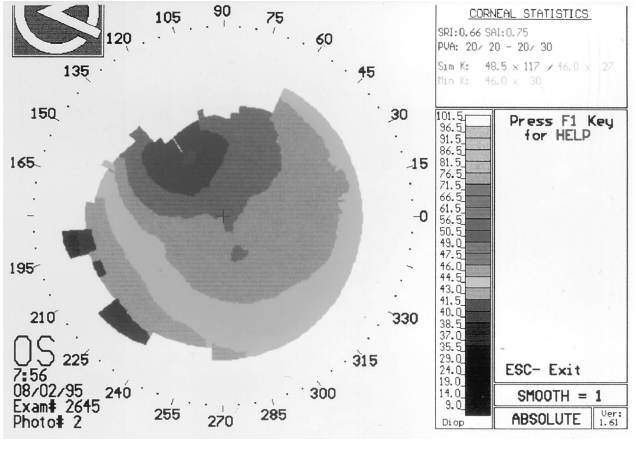

Figure 2. (Sugar) *Case 2*. Computerized corneal topography shows superior corneal steepening.

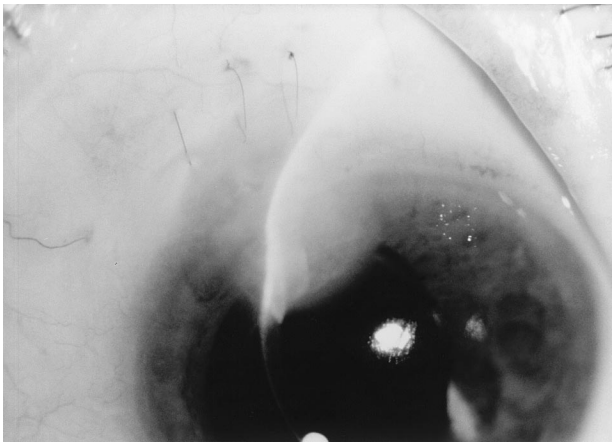

Figure 3. (Sugar) *Case 2*. The area of scarring near the scleral tunnel wound is visible superiorly 8 months after phacoemulsification.

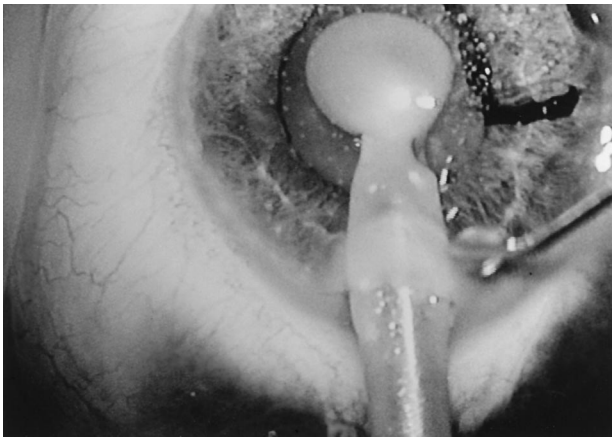

Figure 4. (Sugar) *Case 3*. Intraoperative corneal opacification is apparent at the site of the temporal clear corneal wound. White opacification of viscoelastic material is seen in the anterior chamber at the phacoemulsification tip (frame captured from intraoperative video recording).

the left. The examination in November 1997 was unchanged.

Case 3

A 76-year-old man had a history of mixed-mechanism glaucoma treated with laser peripheral iridotomies in both eyes: argon laser trabeculoplasty in the right eye and trabeculectomy in the left. He had been taking glaucoma medications for 13 years.

The patient had had phacoemulsification in the left eye in May 1997. At the start of nuclear sculpting through a clear corneal temporal incision, a white plume was visible in the anterior chamber at the tip of the phacoemulsification handpiece. Sculpting was stopped and reattempted, but a larger plume of whitened viscoelastic material and whitening of the temporal clear corneal wound were noted (Figure 4). Thinning of the cornea and whitening of a 3.0 × 4.0 mm area were evident. The surgeon had noted a tight fit of the phacoemulsification handpiece in the corneal wound but had attributed it to awkward horizontal hand positioning because of a shallow anterior chamber. In addition, sodium chondroitin sulfate–sodium hyaluronate (Viscoat®) had been used to supplement sodium hyaluronate (Provisc®) to maintain anterior chamber depth during phacoemulsification. The temporal corneal wound was closed with 3 interrupted 10-0 nylon sutures, and a scleral tunnel incision was created superotemporally to avoid the trabeculectomy site at 11 o'clock. The cataractous lens was successfully removed and an acrylic IOL implanted in the capsular bag. The scleral wound was closed with a single X-shaped 10-0 nylon suture.

Two weeks postoperatively, best corrected visual acuity (BCVA) was 20/40 with −5.00 +8.00 × 180. Keratometry was 41.50/50.50 × 180. The temporal wound appeared to be tight. Two of the 3 temporal sutures were removed at this time. Five weeks postoperatively, BCVA was $20/25^{-2}$ with −5.00 +6.00 × 180. The remaining temporal suture was cut. At 8 weeks, visual acuity was 20/25 without correction. Manifest refraction was −1.25 +0.75 × 25 and keratometry was 45.50/46.00 × 30. At 4 months, astigmatism was stable with a manifest refraction of −0.50 +1.00 × 19. The following month, the patient had uneventful cataract extraction by phacoemulsification in the fellow eye. At no time did intraocular pressure (IOP) control worsen. The pilocarpine, which had been stopped several days before surgery to help dilate the pupil, was not restarted in the postoperative period; at last follow-up, IOP was within the intended goal.

Discussion

Corneal and scleral wound burns have been known intraoperative complications of phacoemulsification since the introduction of the procedure.[1] They cause tissue shrinkage around the wound, leading to difficult

wound closure, wound leakage, endothelial damage, iris damage, and astigmatism. In general, wound burns are related to compromise of the flow of fluid around and through the instrument tip and occur within 1 to 3 seconds of loss of flow.[4] Flow problems may be caused by altered inflow related to wound compression of the irrigating sleeve, sleeve kinking by handpiece movements, tubing setup errors, and lowering or emptying of the fluid bottle. Fluid aspiration through the tip bore may be limited by tubing setup errors, tip clogging by nuclear material or viscoelastic material, and inadequate flow rate or vacuum settings.

It has been suggested that there has been a recent increase in phacoburns related primarily to the use of small incisions and viscoelastic materials (I.H. Fine, MD, "Special Report to ASCRS Members: Phacoemulsification Burns"). Ernest has stressed that when viscoelastic material is present, it is important to allow fluid flow to begin before the onset of ultrasound so that some of the material can be aspirated and to avoid clogging the needle with viscoelastic material made excessively viscous by heating (P.H. Ernest, MD, "Thermal Wound Injury During Phacoemulsification," Phacos & Foldables, 10[3]:1–7). This is particularly likely in short eyes with shallow anterior chambers, in which additional viscoelastic material is used, as in Case 3. The use of precooled balanced salt solutions in the irrigating fluid and of pulsed rather than continuous phacoemulsification have also been suggested to decrease the potential for heat generation (R. Osher, MD, S. Yamagami, MD, J. Yamagami, MD, et al. "Complications of Phacoemulsification: Thermal Burns," Audiovisual Journal of Cataract and Implant Surgery, 1993; 9[3]).

Phacoburns have been induced experimentally.[6] In these studies, risk factors for burning have been tubing compression, decreased anterior chamber volume, hard lens nuclei, and high phacoemulsification power. The temperature measured in the anterior chamber near the phacoemulsification tip can exceed 100°C, and the metal tip can get much hotter.[7,8] Histology of both experimental and clinical eyes has shown shrinkage of collagen, scarring, and endothelial damage.[6,9]

Clinical reports of the outcomes of phacoburns are few.[2,3] Davis[2] reported a patient who developed 9.00 D of with-the-rule astigmatism initially after a phacoburn that decreased to 5.00 D and was then treated by astigmatic keratotomy. Davison[3] reported a patient with 6.00 D of induced astigmatism. Cases requiring keratoplasty have been reported, but without clinical detail.[9]

The patients reported in our study developed astigmatism with steepening in the axis of the incision burn. This varied initially from 6.00 to at least 15.50 D. With time, the astigmatism decreased in 2 of the 3 eyes. In the third patient, Case 1, corneal damage was severe and permanent, requiring PKP to treat the astigmatism and corneal edema. The pattern of astigmatism seen on computerized corneal topography is consistent with flattening over a corneal scar, probable loss of anterior stromal tissue, as seen in Case 1, and steepening in the incision axis caused by tissue shortening or loss in the wound, as in the other 2 cases.

Prevention of phacoburns is a critical concern for cataract surgeons. Testing fluid flow before tip insertion, checking for compression of the inflow sleeve after insertion, allowing irrigation and aspiration to clear some viscoelastic material before starting ultrasound, using appropriate vacuum settings, and vigilance during nuclear sculpting will prevent it in most cases. New phacoemulsification tips with noncompressible inflow sleeves and fluted surfaces have been developed to further decrease the risk of this complication. When the complication is recognized instantly by the presence of early tissue whitening or signs of decreased fluid flow (e.g., lens "milk"), further damage can be limited. Specialized suturing techniques—suturing the anterior wound lip to the wound bed rather than the posterior lip—may limit astigmatism (R. Osher, MD, "Gape Closure," Audiovisual Journal of Cataract and Implant Surgery, 1990; 6[3]). When the damage is not severe, the corneal astigmatic changes will tend to decrease over time, although damage may be permanent in more severe cases.

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From the W.K. Kellogg Eye Center, University of Michigan, Ann Arbor, Michigan, USA.

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